

## CLOSURE WITH IMPROVED RESISTANCE TO DEFORMATION DURING OPENING

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### BACKGROUND OF THE INVENTION

#### 1. Field of the Invention

This invention relates generally to closure caps for containers, such as carbonated  
10 beverage containers. In particular, the invention relates to an improved closure that is constructed  
so as to mitigate deformation that would otherwise tend to occur as the closure is being removed  
from the finish portion of a container.

#### 2. Description of the Related Technology

Conventional mating closure caps and bottle finish structures for carbonated beverage  
15 containers typically utilize a screw type or threaded arrangement between the closure cap and the  
finish portion. These types of screw caps are mass produced by injection or compression molding  
and have achieved commercial success mainly in the soft drink industry, where they are applied  
robotically to the finish portions of filled soft drink bottles on rapidly moving filling lines.

One important factor in the design of screw-type closure caps for carbonated beverage  
20 bottles is that of ensuring that the connection between the cap and the finish portion of the  
container is properly vented, so as to permit compressed gases from within the container to be  
released gradually as the cap is unscrewed by the consumer. To achieve the necessary venting, it  
is common for the threads of the finish portions of conventional soft drinks containers to be  
intermittent as opposed to a continuous helix. It is also common for the internal threads of the  
25 closure caps to have periodic gas venting gaps.

Another important consideration in the design of such closures involves the quality of engagement between the closure thread and the threads on the finish portion of the container as the closure is removed from the container. Deformation of the closure that is caused by plastic creep of the closure may have the effect of deforming the closure cap from its original substantially cylindrical configuration into a more oval shape, which decreases the quality of engagement between the threads on the closure and the threads on the finish portion of the container. The creep is a permanent deformation of the plastic caused by stress. This stress is caused by the pressure of the carbonated beverage in the bottle at higher temperatures, and is also caused by higher temperatures softening the plastic over time. The effect is most pronounced when the threads of the closure are close to the open end of the closure, since there is less support to keep the closure in its original form.

This deformation tends to be more pronounced in closure designs where the interior threading of the closure is extended close to the open end of the closure skirt. For example, FIGURES 1 and 2 depict a conventional closure 10 having a top wall 12 and a substantially cylindrical skirt 14 defining an inner surface 16, an outer surface 18 and a lower rim 20. The lower rim 20 is configured so as to possess a minimum width  $W_2$ , which in this example is 0.0364 in. the outer surface 18 of the skirt 14 may be provided with a plurality of flute projections 22 to enhance grippability by a consumer. A plurality of thread projections are defined on inner surface 16 of skirt 14, including a lowermost thread 24 that is positioned so as to be spaced from the lower rim 20 by an axial distance  $H_T$ , which in this example is 0.095 in. A tamper evident band 26 including a J-hook portion 28 is frangibly attached to the lower rim 20 of the skirt 14. Skirt 14 is further molded so as to define an annular recess 29 having a width  $W_1$  (0.0228 in.) and a height  $H_1$  (0.0240 in.) on the inner surface 16 thereof between the lowermost thread 24 and the lower rim 20 of the skirt 14. Referring to FIGURE 2, a reference circle 30 is provided so as to make visible the deformation mentioned above. In this example, a first diameter  $D1$  of the closure 10 was measured at 1.2095 in., while a second diameter  $D2$  was

measured at 1.2450 in. This example illustrates the magnitude of the deformation that is likely to occur using conventional closures.

The thicker the outer wall of the closure skirt, the better the quality of engagement that will be maintained during opening will tend to be. However, material costs for the manufacturer will increase significantly as the thickness of the outer wall is increased.

A need exists for an improved closure design that will ensure an improved dimensional integrity of the closure during opening, particularly in instances where threading is positioned close to the open end of the closure skirt, without substantially increasing material costs for the manufacturer.

### **SUMMARY OF THE INVENTION**

Accordingly, it is an object of the invention to provide an improved closure design that will ensure an improved dimensional integrity of the closure during opening, particularly in instances where threading is positioned close to the open end of the closure skirt, without substantially increasing material costs for the manufacturer.

In order to achieve the above and other objects of the invention, a plastic closure for a container, includes a top wall; a downwardly depending substantially cylindrical skirt that is unitary with the top wall, the skirt defining inner and outer surfaces and further defining a lower rim at a distal, bottom end thereof; at least one thread that is defined on the inner surface of the skirt; and reinforcing structure defined on the skirt in an area between the lower rim and a lowermost thread on the inner surface for enhancing the dimensional integrity of the closure during opening.

These and various other advantages and features of novelty that characterize the invention are pointed out with particularity in the claims annexed hereto and forming a part hereof.

However, for a better understanding of the invention, its advantages, and the objects obtained by its use, reference should be made to the drawings which form a further part hereof, and to the

accompanying descriptive matter, in which there is illustrated and described a preferred embodiment of the invention.

### **BRIEF DESCRIPTION OF THE DRAWINGS**

5           FIGURE 1 is a fragmentary cross-sectional diagrammatic depiction of a portion of a conventional closure;

          FIGURE 2 is a bottom plan view of the conventional closure that is shown in FIGURE 1;

          FIGURE 3 is a fragmentary cross-sectional diagrammatic depiction of a portion of a closure constructed according to a preferred embodiment of the present invention; and

10           FIGURE 4 is a bottom plan view of the embodiment that is depicted in FIGURE 3.

### **DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT(S)**

Referring now to the drawings, wherein like reference numerals designate corresponding structure throughout the views, and referring in particular to FIGURES 3 and 4, a closure cap 40  
15           that is constructed according to a preferred embodiment of the invention includes a top wall 42 and a downwardly depending substantially cylindrical skirt 44 defining an inner surface 16, and outer surface 18 and a lower rim 46 that is positioned at a distal, bottom end thereof. A plurality of threads are defined on the inner surface 16 of the downwardly depending skirt 44, including a  
20           lowermost thread 24 that is positioned more closely to the lower rim 46 than any of the other threads. A plurality of flutes 22 may be defined on the outer surface 18 in order to enhance grippability of the closure 40. A tamper evident band 48 having a J-hook portion 50 is as is conventional frangibly attached to the lower rim 46.

          According to one important aspect of the invention, reinforcing structure 52 is defined on  
25           the skirt 44 in an area between the lower rim 46 and the lowermost thread 24 for enhancing the dimensional integrity of the closure 40 during opening. In the preferred embodiment, reinforcing

structure 52 includes an area of increased skirt thickness between the lower rim 46 and the lowermost thread 24. "Thickness" as the term is used herein means thickness in a radial direction, in other words in a direction that is perpendicular to a longitudinal axis of the closure 40, and is indicated as  $W_T$  in FIGURE 3. "Increased" skirt thickness means that this area is thicker than the corresponding area on conventional closures, such as the conventional closure that is depicted in FIGURES 1 and 2 described above. This area of increased skirt thickness preferably has a relatively smooth inner surface extending unbroken about the inner periphery of the lowermost portion of the skirt 44 so as to define a cylindrical inner surface beneath the lowermost thread 24.

Preferably, this area of increased skirt thickness is at least about 0.05 in. in maximum thickness. More preferably, this area of increased skirt thickness is at least about 0.06 in. in maximum thickness, and most preferably it is at least about 0.07 in. in maximum thickness.

Moreover, a ratio of the width  $W_T$  of the area 52 of increased skirt thickness to the outer diameter  $D_C$  of the skirt 44 is preferably at least about 0.04, and more preferably at least about 0.05.

Additionally, the product calculated by multiplying the width  $W_T$  and a vertical, axial distance  $H_T$  between the lower rim 46 and the lowermost point of the peak of the lowermost thread 24 is preferably at least about 0.0040, more preferably at least about 0.0045 and most preferably at least about 0.0048.

Additionally, the outer surface 18 extends at an angle  $\Theta$  with respect to vertical that is preferably within a range of about 16 to about 28 degrees, and that is more preferably about 22 degrees. The angle is greater than that of the conventional closure described above, which was about 14 degrees, which permits an increase in the thickness  $W_T$ .

For example, a closure 40 according to the preferred embodiment of the invention was constructed so as to have an outer diameter  $D_C$  of 1.2180 in., a thickness  $W_T$  of 0.0702 in. and a

height  $H_T$  of 0.070 in. This closure was determined to possess substantially improved hoop strength characteristics with respect to conventional closures such as those described above.

5 It is to be understood, however, that even though numerous characteristics and advantages of the present invention have been set forth in the foregoing description, together with details of the structure and function of the invention, the disclosure is illustrative only, and changes may be made in detail, especially in matters of shape, size and arrangement of parts within the principles of the invention to the full extent indicated by the broad general meaning of the terms in which the appended claims are expressed.